Thermal classification of salmonid streams and summer distribution of fishes in Nova Scotia with potential implication of climate change

By

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Abstract

Many Nova Scotia streams warmed to stressful levels for brook trout (Salvelinus fontinalis) and Atlantic salmon (Salmo salar). A total of 312 streams have been classified based on mean summer temperature. Streams were classified into three categories based on the mean summer water temperature and known thermal preferences for brook trout. Mean summer water temperatures were <16.5°C for cool streams, between 16.4 and 19°C for intermediate streams, and ≥19°C for warm streams. Of these, one hundred streams were electrofished to determine if salmonids were influenced by thermal conditions in the summer.

Salmon parr population densities ranged from zero to 65 fish/100m^2 and did not appear to be greatly influenced by water temperature. Brook trout population densities ranged from zero to 332 fish/100m^2 and appeared to be strongly influenced by summer water temperature. The mean population density of brook trout was 55 fish/100m^2 in 35 cool water streams, 14 fish/100m^2 in 29 intermediate streams, and 2 fish/100m^2 in 36 warm water streams. Competitors of salmonids were present in 43% of cool water streams, 62% of intermediate water streams, and 89% of warm water streams.

The results of the survey clearly indicated that cool water streams are vital to brook trout during warm summer conditions in Nova Scotia. The Nova Scotia salmonid stream classification system worked very well to describe brook trout habitat. The salmonid stream classification of watercourses will be used to assess the potential success of future trout fishery enhancement strategies in Nova Scotia. The temperature classification system can be used as a guide for community groups undertaking riverine habitat restoration efforts.

Introduction

Brook trout and Atlantic salmon are members of the salmonid family, and require cool water habitat in order to survive. Brook trout are one of the most sensitive salmonids to warm water, and avoid temperatures greater than 20°C, whereas brown trout and Atlantic salmon are slightly more tolerant of warmer waters (Coutant 1977). In response to thermal stress from warm water, brook trout will migrate to cooler waters (Elson 1942, Gibson 1966, Biro 1998).

Climate changes and poor land use practices have increased water temperatures, and decreased flow rates and water levels (Schindler 2001). Different climate change scenarios for the maritime provinces indicate that warming in the range of 2-4°C will occur over the next 50 years (Parks Canada 1999). Currently, many Nova Scotia stream systems warm to temperatures (>20°C) and are considered to be seasonally unsuitable for salmonids. Future warming of freshwaters by just 2°C could result in significant loss of cool water habitat. A total of 312 streams in Nova Scotia were classified into three thermal categories cool (ideal for brook trout), intermediate (marginal), and warm (unsuitable for brook trout) (MacMillan et al 2005). The purpose of this study was to test the water temperature classification system that was developed by the Nova Scotia Department of Agriculture and Fisheries. The Nova Scotia stream classification system was based on the assumption that cool water sites are more important to Atlantic salmon and brook trout populations during warm low flow conditions in summer. Salmonid population and habitat data was collected from 100 stream sites that were previously assessed through the Nova Scotia water temperature monitoring program.

Methods

Two survey teams collected habitat and fish data in 100 streams on 23 river systems (Figure 1). Streams surveyed were formerly classified into three categories (cool, intermediate, and warm) based on mean summer water temperatures. The number of streams and the mean summer temperatures in each category was 35 cool (<16.5°C), 29 intermediate (16.4-19°C), and 36 warm (≥19°C). Volunteer organizations participated in the collection of habitat and population information during the summers of 2002, 2003, 2004, and 2005 (Appendix A).

Electrofishing site habitat survey measurements of stream length, stream width, and depth were recorded in meters. Four cross channel stream widths or transects were recorded in each electrofishing site. Stream width measurements were taken along with stream depths at the left, middle, and right of the channel in each transect. The depths across each channel were measured with a meter stick and substrate (silt/ cobble/ boulder/ rock/ bedrock/ gravel), cover (instream/ vegetation/ canopy trees/ overhang vegetation/ absence of cover), and water characteristics (riffle/ run/ flat) were identified at each of the three points along the transect line. Undercut banks were recorded once per transect line. Presence of undercut was represented as a proportion of stream length. In 2002 and 2003 undercut bank cover was recorded if the bank cover extended over one of the instream transect points where other habitat parameter were recorded, This was believed to underestimate the presence of undercut banks. This methodology was modified. In 2004 and 2005, undercut banks were defined as present along any length of the stream transent line. Mean habitat parameters were determined for each thermal category. Water acidity (pH) was recorded at each site using a YSI meter.

The one sweep electrofishing method was used to increase the number of population estimates that could have been conducted by traditional electrofishing techniques, using three electrofishing sweep method with barrier nets, as described in Jones and Stockwell (1995). Population data from previous electrofishing surveys in Nova Scotia were used in the development of the one sweep method. The one sweep method used the relationship between the number of trout caught in the first electrofishing sweep and the total population estimate obtained from the electrofishing three sweep method. The linear equation, $y=1.93$, $r^2=0.834$, where x = number of fish caught in single sweep and y= population estimate, from a regression analysis was used to define the relationship and allow for an estimate of total population from one electrofishing sweep. The absence of barrier nets used in the one sweep method and was not believed to have a significant impact on fish escapement because of the size of the streams sampled. Brook trout biomass (grams per $100m^2$) estimates were calculated for electrofishing sites from the weight-length relationship ($W=0.008*L^{3.12}$, w=weight in g, L=length in cm) from the Nova Scotia brook trout inventory database.

All fish species were identified and counted. The population (fish per $100m^2$) of fish species other than salmonids were estimated using the one sweep method. Mean summer water temperature was plotted against the number of trout and salmon per $100m^2$ to identify if a relationship existed. The percentage of competitors in each of the three thermal categories was determined.

Results

Electrofishing site habitat parameters relating to depth, width, temperature, substrate, cover were recorded from 100 streams on 23 river systems. The mean values for each habitat parameter was calculated for streams in each of the three thermal categories. The mean number of days when the daily mean temperature exceeded 20°C was zero days for the cool water category, 6 days for the intermediate category, and 51 days for the warm water category (Table 1). Mean stream width was 3.5 m for cool water sites, 3.9 m for intermediate water sites, and 5.9 m for warm water sites. Mean depth was similar in each thermal category and was 0.20 m (Figure 2). Mean silt substrate type was 19% for cool water sites, 14% for intermediate water sites, and 16% for warm water streams. Cobble and gravel were the most common substrate type and covered approximately 63% of cool water sites, 65% of intermediate sites, and 60% of warm water sites. Other substrate types of boulder, rock, and bedrock were similar in each thermal category (Figure 3). Warm water streams had the highest mean (29%) for instream cover and the lowest mean (34%) for canopy cover. More solar exposure for growth on instream plants probably occurred on warm water streams. Overhang cover was highest (36%) in the cool water category. Small width of cool streams could be related to the abundance of overhang cover. Undercut cover was present along the stream length of 44% of cool water sites, 34% of intermediate sites, and 18% of warm water sites sampled in 2004 and 2005 (Figure 4). Flat was the dominant water characteristic in all three thermal categories (Figure 5).

The mean population density for brook trout was 25 fish per $100m^2$ and ranged from 0 to 332 fish per $100m^2$. The mean biomass density for brook trout was 449 g per $100m^2$ and ranged from 0 to 6756 g per $100m^2$ (Appendix B). Sites with above mean population densities of brook trout tended to be found in the cool water category (Figure 6). Sites with above mean salmon population densities were located in all three thermal categories (Figure 7). The mean number of trout per $100m^2$ in each thermal category was 55 in the cool water category, 14 in the intermediate water category, and 2 in the warm water category. The mean number of Atlantic salmon juveniles per $100m^2$ in each thermal category was 9 in the cool water category, 5 in the intermediate water category, and 4 in the warm water category (Figure 8).

Fish species considered to be competitors of salmonids captured in electrofishing sites included white sucker, yellow perch, white perch, smallmouth bass, American eel, chain pickerel and brown bullhead (Appendix C). The presence of competitors was related to summer water temperature in the electrofishing sites. The percentage of sites with competitors in each thermal category was 43% in cold water streams, 62% in intermediate water streams, and 89% in warm water streams (Figure 9). Other fish species captured in electrofishing sites that were not considered to be competitors of salmonids were cyprinids, gaspereau, banded killifish, and stickleback (Table 2).

The water acidity (pH) in 100 sites ranged from 4.2 to 7.9, with a mean of 6.7 (Appendix B). The mean water acidity (pH) was 7.1 in the cool water category, 6.8 in the intermediate water category, and 6.3 in the warm water category (Table 1). Brook trout density was greater in sites where the pH was 6.0 or higher (Figure 10). Higher mean summer temperatures was related to lower pH (Figure 11).

Discussion

The distribution of Atlantic salmon did not seem to be strongly related to the thermal nature of streams in our study. Summer thermal conditions in many Nova Scotian rivers are potentially more favourable for Atlantic salmon because of their tolerance to warmer conditions compared to brook trout; however, thermal death of salmon have been reported in Nova Scotia rivers (Huntsman 1945). Another factor affecting juvenile Atlantic salmon population densities could be differences in recruitment among rivers surveyed. Critically low salmon population levels occur in rivers of mainland Nova Scotia. In many cases, low abundance of juvenile Atlantic salmon may be related to limited recruitment rather than reflect habitat conditions in fresh water (Amiro 1998 and 1998a).

Brook trout population density was strongly related to mean summer temperature. Nova Scotia streams that had a summer mean water temperature of 19°C and warmer had either very few or an absence of brook trout. The mean biomass of trout was sixty-one times larger in cool water sites compared to warm water sites. The results of the survey clearly indicated that water temperature was a major factor influencing the distribution of trout. In fact, when compared to other habitat parameters such as cover, water depth, and stream bottom type, cool water temperature appeared to be the most important factor regulating the number of trout present. This result is in agreement with Stoneman and Jones (2000) who reported that water temperature was the single most important factor that separated trout streams from non-trout streams.

Geology, soil type, vegetation cover, precipitation and land use activities play an important role in influencing water chemistry and quality. Surface water acidification is of worldwide concern, and increased acidity has also been implicated in the decline of fish populations in many countries (Lehane et al., 2004). Underlying geology will greatly influence the pH and hardness of surface waters. Brook trout population density was higher in streams where the pH was 6.0 or greater. For example, sites surveyed in Cape Breton had a pH range from 6.4-7.8 and showed much higher brook trout densities compared to the southern part of Nova Scotia where the pH ranged from 4.2-7.9 and had very low trout densities. Certain areas in Nova Scotia contain soils with greater ability to reduce acidity (high buffering capacity) and have a higher carbonate content compared in mainland Nova Scotia.

Warming may result in significant changes to populations of cold water fishes (Schindler 2001). During periods of increased water temperature, brook trout will often respond by migrating to areas of cooler water (Biro 1998, Fry 1951, Gibson 1965). Previously in Nova Scotia, Elson (1942) reported that brook trout migrated into cool stream (12-14°C) from the warm 21°C water in Lake Ainslie. These migrations are an example of behavourial thermoregulation and have helped fish to avoid harmful temperatures but can

result in large numbers of fish moving into a small overcrowded area where problems influencing survival may occur.

Overcrowded populations are more susceptible to predation, over fishing, parasites, disease transmission, and competition (Coutant 1987). Commonly known predators of salmonids include kingfishers, mergansers, otter, great blue herons, osprey, cormorants, and mink. Under most circumstances predators are opportunistic and may be attracted to areas where prey is abundant and easily caught. These areas could be the overcrowded trout populations in cool water refugia. Anglers are also opportunists and like predators of trout, anglers have the potential to remove high numbers of trout under certain conditions. Fish health could be influenced as parasites and diseases could be transmitted more efficiently through a crowded population compared to through a dispersed population.

Competition for food and space is an important factor in density dependent mortality in salmonids (Chapman 1966). Even when food is not limiting salmonids will still have a territory to occupy and defend against other salmonids. Heavy interspecific competition could result when trout are forced to compete for limited food resources and habitat in the space-limited cool water refugia during warm periods in the summer. Density dependence could result in poor condition and slow growth and reduced survival from prolonged stays in space limited cool water refugia.

Predation and competition can play a significant role in mortality rates in salmonids (Alexander 1979). In Nova Scotia, fish species considered to be competitors of salmonids include: white perch, yellow perch, smallmouth bass, chain pickerel, white sucker, American eel, and brown bullhead. The results of the Nova Scotia electrofishing survey indicated that the highest percentage (89%) of sites with competitors was found in the warm water category and the lowest percentage (43%) of sites with competitors was found in the cool water category. Trout, and salmonids in general, are considered to be poor competitors to many other fish species. Trout populations in the presence of many fish competitors will tend to be less healthy compared to trout populations in a habitat with few fish competitors. Most of the fish considered to be important competitors of trout prefer warmer water, and, as a result, these warmer conditions could increase habitat for competitor populations. Stressors on trout populations could be significant as many competitors may feed on similar prey items as trout or may feed on trout directly.

Thermal restriction can lead to numerous and sometimes complex effects on fish populations. The results of this electrofishing survey clearly indicate that cool water habitat is very important to brook trout survival in Nova Scotia stream systems. The results of the Water Temperature Monitoring Project had indicated that the fresh water conditions in Nova Scotia rivers are sensitive to environmental changes; for example, a 2°C increase in summer mean water temperature would result in an estimated 50% reduction in the number of cool water streams and result in an estimated 58% increase in the number of

warm water streams (MacMillan et al 2005). Future climatic warming and careless land use and development practices may exacerbate warm conditions in freshwater (Meisner 1990, Li et al. 1994). The future may hold large changes for salmonid habitats. For this reason, focusing on conserving our cool water habitat in streams, lakes, and protecting and enhancing habitats could be of great benefit to the salmonid resource in the province. Maintaining buffer strips along waterways can be one of the most effective ways to maintain cool waters by minimizing sunlight exposure (Barton et al. 1985). Many volunteer organizations involved in this project have been involved in stream habitat enchantment projects.

The results of the survey clearly indicated that cool water streams are vital to brook trout during warm summer conditions in Nova Scotia. The Nova Scotia salmonid stream classification system worked very well to describe brook trout habitat. Other factors seem to be controlling distributions and population density of Atlantic salmon juveniles. The salmonid stream classification of watercourses will be used to assess the potential success of future trout fishery enhancement strategies in Nova Scotia.

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Table 1. Mean salmonid population densities and habitat data in each thermal category from 100 electrofished stream sites in 2002-05 in Nova Scotia.

Thermal category average summer water temperature	Number of Sites	Water acidity pH	Water temperature °C mean summer	average warmest daily	Number of days >20°C	Brook trout biomass g/100m²	per 100m²	Salmon per 100m²	Brown trout per 100m²	Mean width m	depth m	Substrate percentages S	Co	B	R	Be	G	Cover percentages In	Ca	Un*	O	NC	Water characteristic percentages Ri	Ru	F
Cool <16.5°C	35	7.1	14.0	16.9	0	1089	55	9	7	3.5	0.20	19	34	1	18	1	29	19	41	22	36	19	12	30	57
Inter 16.5 - 19°C	29	6.8	17.3	21.3	6	211	14	5	0.2	3.9	0.20	14	31	2	20	1	34	24	45	18	23	28	3	19	78
Warm >19°C	36	6.3	20.7	24.5	51	18	2	4	0	5.9	0.20	16	31	2	22	1	29	29	34	9	27	26	11	28	61

m = meters g= grams inter = intermediate

Substrate S=silt, Co=cobble, B=boulder, R=rock, Be=Bedrock, G=gravel

Cover In=instream, Ca=canopy, Un=undercut, O=overhang, NC=no cover

Un* = respresents data collected in 2004 and 2005

Water Characteristic Ri=riffle, Ru=run, F=flat

Table 2. Mean fish population densities in each thermal category from 100 electrofished stream sites in 2002-05 in Nova Scotia.

Thermal category	Number of Sites	Water acidity pH	Summer mean Temp °C	Number of fish per 100m² Brook trout	Atlantic salmon	Brown trout	White sucker	Yellow perch	Eel	SMB	Brown bullhead	Gas	Stickle back	Killi fish	Cyprinids	Chain Pickerel	Percentage of site with competitors
Cool <16.5°C	35	7.1	14	55	9	7	1.1	0	1.9	0.0	0	0	0.3	0	3	0	43%
Inter 16.5 - 19°C	29	6.8	17	14	5	0.2	2.9	0.4	0.6	0.0	0.10	0	0	0	4	0	62%
Warm >19°C	36	6.3	21	2	4	0	3.2	0.2	11	0.0	0	1.2	0.1	1.1	7	0.1	89%

Salmonid competitors: White sucker, Yellow perch, Eel, Smallmouth bass (SMB), Brown bullhead, Chain pickerel

Gas : Gaspereau

LEGEND

Number	System	County
1	Middle R	Victoria
2	Baddeck R	Victoria
3	Margaree / L Ainslie	Inverness
4	R Denys	Inverness
5	East R Pictou	Pictou
6	St Mary's R	Guysborough
7	Sackville R	Halifax
8	Mushamush R	Lunenburg
9	LaHave R	Lunenburg
10	Petite Riviere	Lunenburg
11	Roseway R	Shelburne
12	Clyde R	Shelburne
13	Annis R	Yarmouth
14	Tusket R	Yarmouth
15	Annapolis R	Annapolis
16	Cornwallis R	Kings
17	Habitant R	Kings
18	Avon R	Hants
19	Kennetcook R	Hants
20	Nine Mile R	Hants
21	Salmon R	Colchester
22	Wallace R	Cumberland
23	R Philip	Cumberland

Figure 1. Location of 23 river systems included in the Nova Scotia Salmonid Population Assessment Project, 2002-2005.

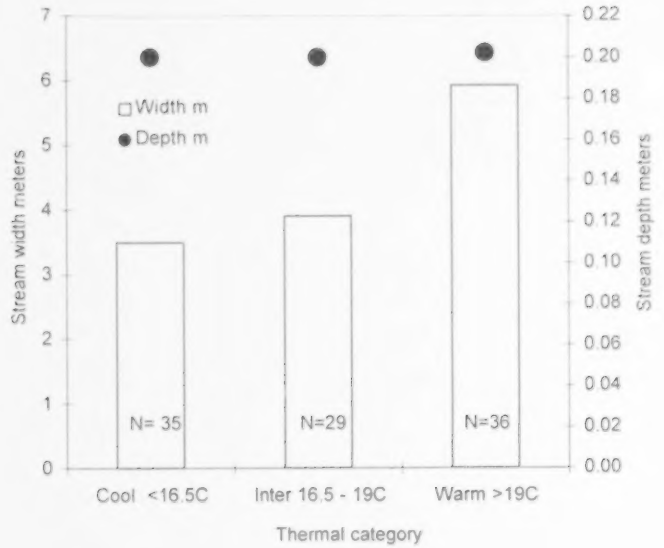

Figure 2. Mean width and depth in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.

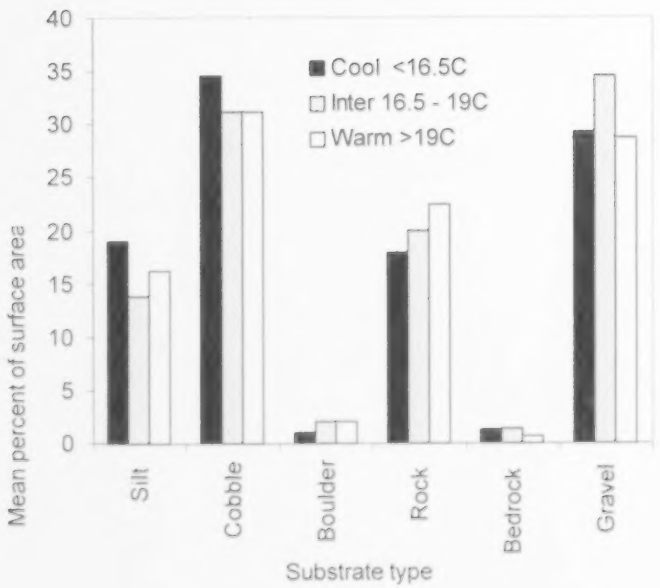

Figure 3. Mean percentage of each substrate type in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.

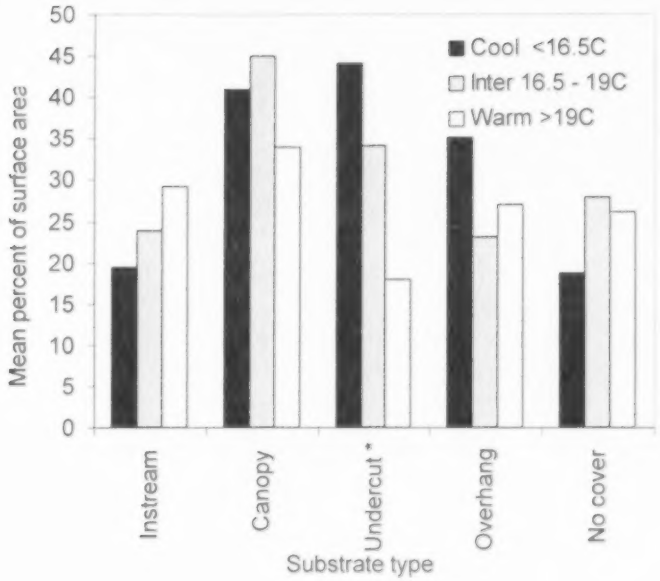

Figure 4. Mean percentage of each cover type in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.
* undercut represents data from 2004 and 2005

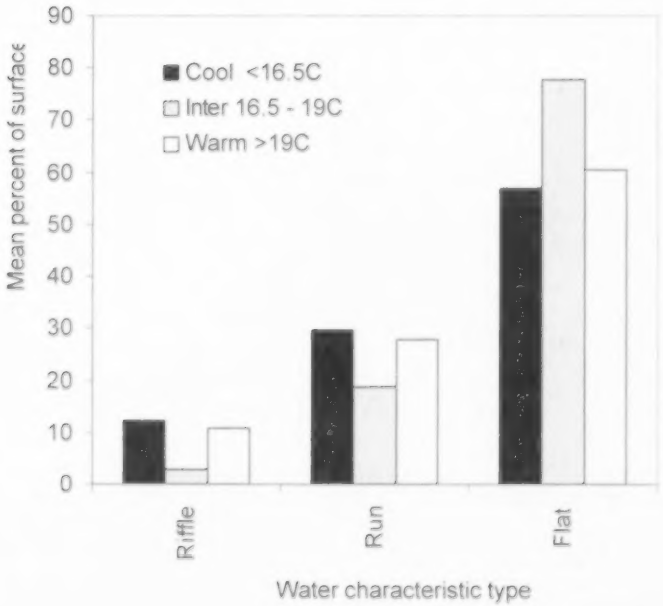

Figure 5. Mean percentage of each water characteristic type in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.

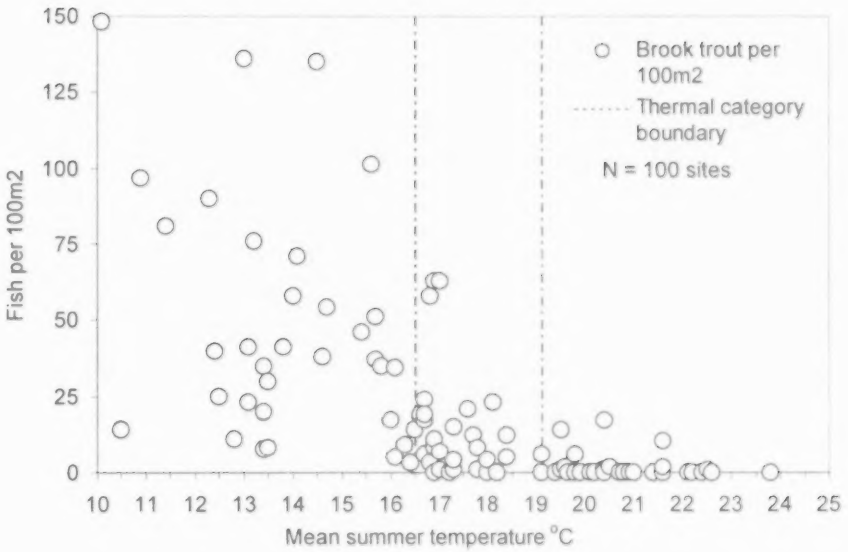

Figure 6. Brook trout population densities (fish per 100m^2) and mean summer water temperature from 100 electrofished stream sites, Nova Scotia, 2002-05.

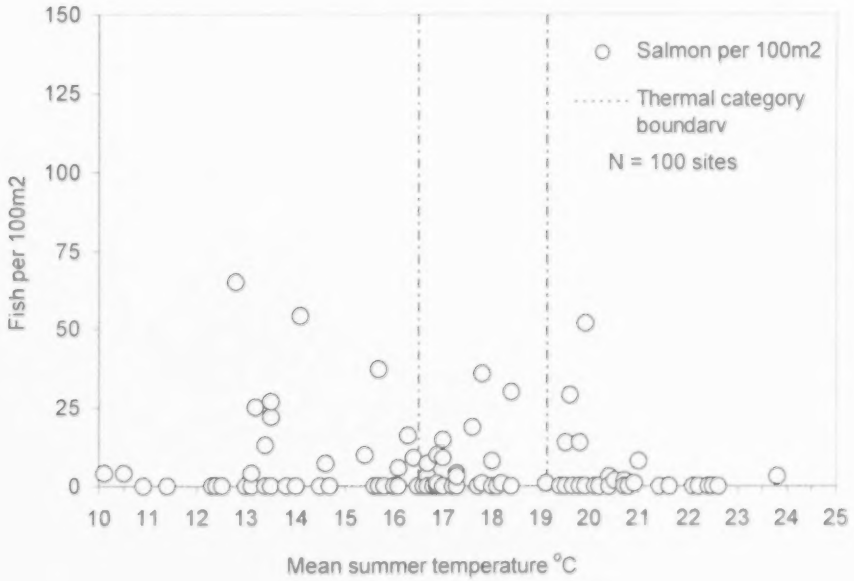

Figure 7. Atlantic salmon population densities (fish per 100m^2) and mean summer water temperature from 100 electrofished stream sites, Nova Scotia, 2002-05.

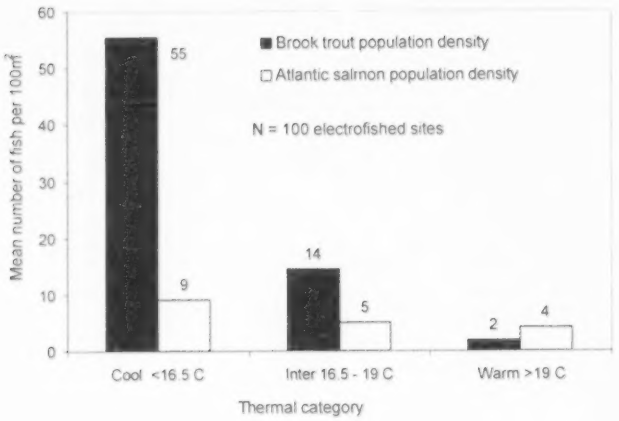

Figure 8. Mean population densities (fish per 100m2) of brook trout and Atlantic salmon juveniles in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.

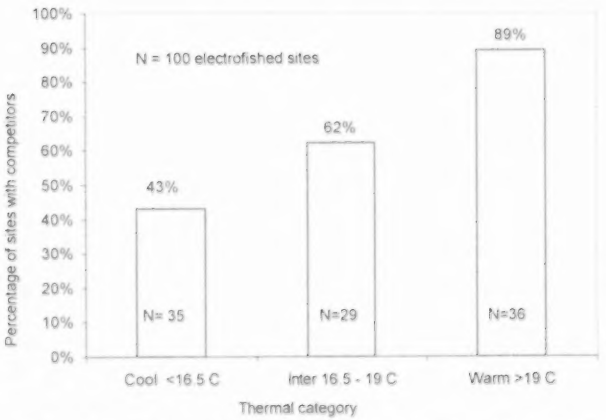

Figure 9. Percentage of sites with competitors of salmonids in each thermal category from 100 electrofished stream sites, Nova Scotia, 2002-05.

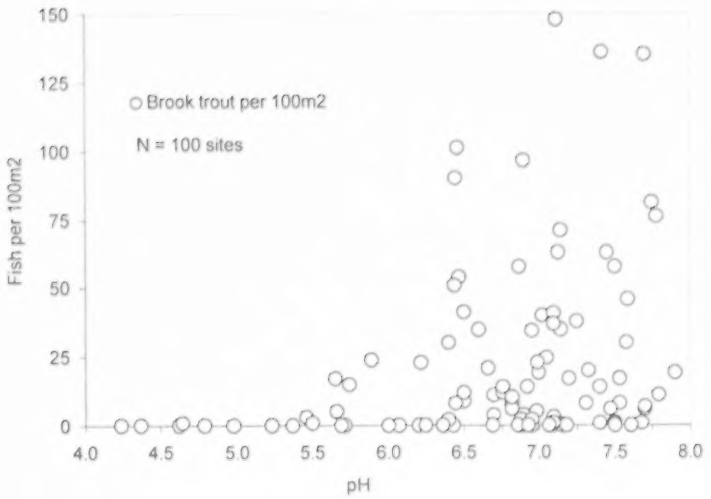

Figure 10. Brook trout population densities (fish per 100m^2) and water acidity (pH) from 100 electrofished stream sites, Nova Scotia, 2002-05.

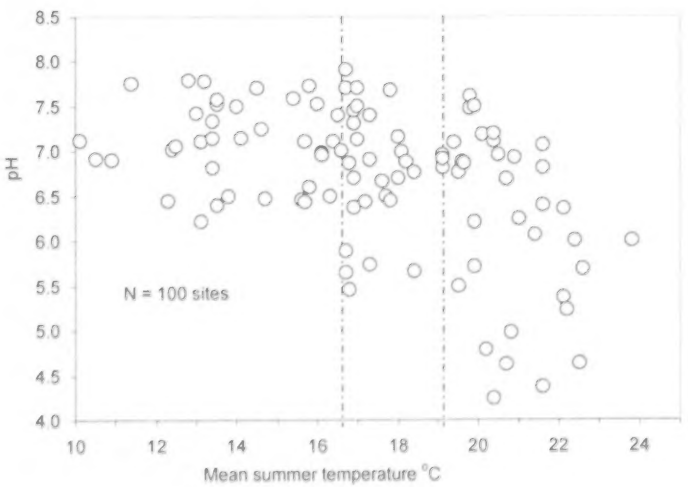

Figure 11. Mean summer temperature and water acidity (pH) from 100 electrofished stream sites, Nova Scotia, 2002-05.

Appendix A. Organizations and volunteers involved in the Nova Scotia Salmonid Population Assessment Project, 2002-05.

Contact	Organization	River
Billy Stevens	Cape Breton Sportfishing Advisory Council	Middle
Jack MacKillop	Cape Breton Sportfishing Advisory Council	Baddeck
Mary MacNeil	L.Ainslie and Margaree River Hertiage Association	L.Ainslie & Margaree
John King	Stewards of River Denys Watershed Association	River Denys
Bill Carpin	St. Mary's River Association	St. Mary's
Bill Cardiff	Pictou County Rivers Association	East & West Pictou
Brooke Cook	Bluenose Atlantic Coastal Action Project	Mushamush
Carol Randall	LaHave Salmon Association	LaHave
Garth Trider	LaHave Trout Association	Upper LaHave
Doug Bell	Petite Riviere Association	Petite Riviere
Paul Smith	NS Fed Anglers and Hunters / Shel Co. Fish and Game	Roseway
Richard Swaine	NS Fed Anglers and Hunters / Shel Co. Fish and Game	Clyde
Charles Trask	Tusket River Environ Protection Association	Tusket
Roland Smith	Annapolis Fly Fishers	Nictaux
Stephan Hawbolt	Clean Annapolis River Project	Annapolis
Doug Warner	Habitant River Trout Association	Habitant & Pereaux
Mike Brylinsky	Estuarine Center Biology Department Acadia University	Habitant
Peter Bagnall/Derrick Fritz	Friends of Cornwallis River	Cornwallis
Darrel Brown	Wildlife Habitat Advocates	Avon & Kennetcook
Danny Ripley	Cumberland County River Enhancement Association	Philip & Wallace
Walter Regan	Sackville River Association	Sackville
Chris van Slyke	Nine Mile River Association	Nine Mile River

Appendix B. Water temperature, salmonid population densities, and habitat data collected from 100 electrofished stream sites in 2002 - 2005 in Nova Scotia.

				Water temp °C		Number	Brook trout		Atl	Brn t	Comp		Mean	Mean	Substrate Percentages						Cover Percentages					Water Char Percentages			
				mean	warm	of days		per	Sal	per	Species		width	depth															
Year	System	Site	Date	sum	daily	>20°C	g/100m²	100m²	100m²	100m²	P / A	pH	m	m	S	Co	B	R	Be	G	In	Ca	Un	O	NC	Ri	Ru	F
2002	East River	Mill Stream Bk	13-Aug	19.8	21.4	28	53	6	14	0	A	7.5	3.1	0.13	0	58	0	0	0	42	8	92	0	0	0	25	25	50
		Archibald Bk	13-Aug	17	21.2	7	33	1	9	3	A	7.5	4.4	0.19	0	58	0	0	0	42	0	17	0	17	67	0	8	92
		Cameron BK	13-Aug	17.6	21.7	10	447	21	19	0	A	6.7	3.1	0.19	7	60	0	13	0	20	0	20	13	40	67	33	0	67
		West Branch	13-Aug	19.6	22.3	27	0	0	0	0	A	6.9	4.6	0.18	8	17	0	8	0	67	8	58	0	8	42	8	17	75
		Thompson Bk	13-Aug	15.7	18.7	0	409	51	0	0	A	6.4	2.9	0.20	17	25	8	17	0	33	33	0	0	50	25	33	0	66
		Little River	13-Aug	15.8	19	0	693	35	0	0	A	6.6	3.7	0.19	0	67	0	0	0	33	17	0	13	42	33	0	0	100
	Margaree/	Saddlers Bk	14-Aug	18.4	21.2	10	267	12	0	0	A	6.8	3.8	0.21	42	25	0	8	0	25	33	67	0	17	0	0	0	100
	Lake Ainslie	Dan MacDonald Bk	14-Aug	16.9	21.9	9	201	63	0	0	A	7.5	2.5	0.10	0	33	0	25	0	42	0	67	13	8	17	17	0	83
		MacMillan Bk	14-Aug	14.7	17.8	0	1368	54	0	0	A	6.5	4.0	0.13	0	83	0	8	0	8	0	83	0	17	8	0	42	59
		Johnson Bk	14-Aug	12.3	15.2	0	3862	90	0	0	A	6.5	3.4	0.20	0	50	0	8	0	42	0	100	0	8	0	0	33	67
		MacSweens Bk	14-Aug	13.5	17.4	0	736	30	0	0	A	6.4	3.4	0.14	25	17	0	0	0	58	0	58	0	8	33	0	67	33
	River Denys	Alder River	15-Aug	13.2	17	0	428	76	25	0	A	7.8	4.9	0.18	0	25	0	8	0	67	0	0	0	8	100	25	17	58
		Glen Bk	15-Aug	15.4	20.4	2	334	46	10	0	A	7.6	3.8	0.31	17	33	8	8	0	33	0	33	0	42	50	42	0	58
		McIntyre Bk	15-Aug	16.9	23	10	439	8	1	1	A	7.3	5.1	0.24	0	42	0	8	0	50	0	33	0	42	50	0	0	100
		MacLellans Bk	15-Aug	17.8	27.7	22	19	1	1	0	A	7.7	4.5	0.19	0	33	0	0	0	67	0	8	0	8	92	0	17	83
		Big Brook	15-Aug	18	23.5	16	0	0	0	0	A	7.2	8.5	0.28	0	58	0	0	0	42	0	0	0	17	83	0	17	83
	Annapolis	McGee Bk	20-Aug	14	15	0	885	58	0	0	P	7.5	1.7	0.23	8	25	0	17	33	17	0	0	0	100	0	0	0	100
		Wiswall River	20-Aug	18.1	20.7	0	611	23	0	0	P	7.0	3.2	0.10	50	8	0	0	0	42	42	58	13	25	83	0	33	67
		Round Hill River	20-Aug	20.9	25.7	47	0	0	1	0	P	6.9	7.4	0.13	0	100	0	0	0	0	0	33	0	8	58	0	58	42
		Bloody Creek	20-Aug	20.5	25.7	41	71	2	2	0	P	7.0	5.9	0.25	0	58	0	8	0	33	0	8	0	17	75	0	33	67
		Paradise Bk	20-Aug	19.1	22.9	21	90	6	1	0	P	6.8	4.9	0.16	0	50	0	0	0	50	0	83	0	0	17	0	0	100
		Patterson Bk	20-Aug	15.8	19.3	0	6756	332	0	0	P	7.7	1.9	0.27	58	0	0	42	0	0	25	0	13	92	8	8	8	83
	Habitant	Sleepy Hollow Bk	21-Aug	14.5	18.5	0	251	135	0	0	A	7.7	1.9	0.09	92	0	0	0	0	85	25	50	13	75	0	0	25	75
		Pereaux Bk	21-Aug	11.4	13.7	0	1977	81	0	0	A	7.8	2.2	0.09	100	0	0	0	0	0	8	92	0	33	0	0	42	58
		Upper Habitant	21-Aug	13	15.6	0	3841	136	0	0	P	7.4	2.8	0.15	100	0	0	0	0	0	0	75	0	25	8	0	8	92
	Cornwallis	Sharpes Bk	21-Aug	13.1	15.1	0	394	41	0	9	P	7.1	4.8	0.13	0	58	0	0	0	42	0	100	0	0	0	33	33	33
		Tupper Bk	21-Aug	17	22	9	499	63	0	0	A	7.1	2.9	0.19	0	8	0	0	0	92	0	100	0	0	0	0	0	100
		Brandywine BK	21-Aug	17.3	21	6	60	1	0	1	A	7.4	3.6	0.32	50	0	0	0	0	50	0	75	0	8	17	0	0	100
		Spidle Bk	21-Aug	13.4	16.1	0	260	35	0	72	A	7.1	3.3	0.16	8	42	0	0	0	50	0	42	0	17	42	25	50	25
	Kennetcook	Birch Bk	22-Aug	16.1	19.6	0	47	5	0	0	P	7.0	4.0	0.11	0	92	8	0	0	0	0	58	0	0	42	17	33	50
		Rines Bk	22-Aug	20.1	24.1	43	0	0	0	0	P	7.2	3.9	0.27	0	33	0	0	0	67	0	33	0	0	67	17	25	58
		Hanna Bk	22-Aug	19.4	25.6	34	0	0	0	0	P	7.1	3.6	0.18	8	67	8	8	0	8	8	25	0	58	33	0	0	100
		Upper Kennetcook	22-Aug	16.6	20.4	1	54	19	0	0	P	7.0	3.4	0.13	0	80	8	0	0	42	0	58	0	17	25	0	17	83
	Mushamush	Blockhouse Mill Bk	27-Aug	19.1	23.5	25	0	0	1	0	P	7.0	3.1	0.10	0	25	0	8	0	67	33	67	0	50	0	50	0	50
		Mushamush River	27-Aug	20.7	26.3	50	0	0	2	0	P	6.7	13.1	0.26	0	25	0	58	0	17	50	0	0	17	33	25	42	33
		Naas Bk	27-Aug	19.5	24.4	37	60	14	0	0	P	6.8	2.3	0.06	25	0	0	8	0	67	67	25	0	50	0	42	0	58
		Mushamush R by lake	27-Aug	19.1	22.1	20	0	0	1	0	P	6.9	5.2	0.12	8	50	0	0	0	42	8	75	0	42	25	8	33	58
		Caribou Bk	27-Aug	18.2	21.4	5	0	0	1	0	P	6.9	4.5	0.21	25	8	28	17	0	25	25	33	0	42	25	0	25	75
		Big North Bk	27-Aug	22.6	30.2	65	0	0	0	0	P	5.7	4.8	0.20	0	25	25	42	8	0	50	67	0	17	8	0	42	58
	Petite Riviere	Wamback Mill Bk	28-Aug	17.3	22.4	9	533	15	4	0	P	5.7	6.0	0.17	0	0	0	100	0	0	50	25	0	33	0	8	0	92
		Petite Riviere	28-Aug	21	26.1	55	0	0	8	0	A	6.3	7.5	0.31	0	8	0	92	0	0	100	0	0	0	0	58	42	0
	La Have	Rhyno Bk	28-Aug	23.8	24.7	74	0	0	3	0	P	6.0	6.6	0.17	0	0	0	42	0	58	75	0	0	17	25	42	8	50
		Ash Bk	28-Aug	16.7	22.6	8	213	17	3	0	P	5.7	3.1	0.18	8	33	0	17	17	25	0	100	13	25	0	0	8	92
		Cooks Bk	28-Aug	17.8	22.7	11	15	8	36	0	P	6.5	3.2	0.08	17	25	8	25	0	25	33	75	0	25	0	0	25	75
		Varner Bk	28-Aug	13.1	20	1	790	23	4	0	P	6.2	2.8	0.19	0	17	0	83	0	0	25	67	13	33	8	0	0	100

Appendix B. Water temperature, salmonid population densities, and habitat data collected from 100 electrofished stream sites in 2002 - 2005 in Nova Scotia.

				Water temp °C		Number	Brook trout		Atl	Brn t	Comp		Mean	Mean	Substrate Percentages					Cover Percentages						Water Char Percentages		
				mean	warm	of days		per	Sal	per	Species		width	depth														
Year	System	Site	Date	sum	daily	>20°C	g/100m²	100m²	100m²	100m²	P / A	pH	m	m	S	Co	B	R	Be	G	In	Ca	Un	O	NC	Ri	Ru	F
2003	Wallace	Drennan Bk	28-Aug	19.9	23.7	38	0	0	52	0	P	7.5	5.2	0.16	17	33	0	17	0	33	25	0	0	8	67	58	17	0
	St. Mary's	Nelson Bk	27-Aug	20.4	25.4	46	50	1	3	0	P	7.1	7.3	0.19	25	8	0	8	8	50	50	0	0	17	33	8	8	83
		Cross Bk	27-Aug	16.9	23.1	14	0	0	10	0	P	6.4	3.3	0.22	17	33	8	8	0	33	17	33	13	25	17	17	0	83
		Kelly Bk	27-Aug	16.7	17.5	0	533	24	0	0	A	5.9	2.3	0.12	0	8	8	17	25	42	42	50	0	0	8	8	33	58
		Barren Bk	27-Aug	18.4	21.4	9	109	5	30	0	P	5.7	3.9	0.24	0	33	0	8	0	58	8	33	13	17	34	0	83	0
	Middle	MacLeod Bk	19-Aug	13.5	14.2	0	70	8	22	0	A	7.5	9.7	0.16	8	58	0	33	0	0	0	8	13	17	67	0	100	0
		Morrison Bk	18-Aug	12.8	13.9	0	100	11	65	0	A	7.8	3.2	0.18	0	50	0	50	0	0	25	33	0	25	17	0	75	25
		MacKenzie Bk	19-Aug	13.5	14.9	0	967	30	27	0	A	7.6	4.5	0.20	0	33	0	58	0	8	58	17	25	17	0	17	50	33
		MacDonald Bk	19-Aug	10.1	11.5	0	1812	148	4	0	A	7.1	2.7	0.08	0	75	0	25	0	0	42	0	38	42	0	17	58	25
	Baddeck	Harris Bk	18-Aug	14.6	16.5	0	1902	38	7	0	A	7.3	5.0	0.10	25	0	0	8	0	67	8	17	0	50	25	0	17	84
		Mill Bk	18-Aug	13.4	16.9	0	592	20	13	0	A	7.3	2.9	0.08	17	75	0	8	0	0	0	33	0	25	42	33	25	42
		Morgan Bk	18-Aug	19.6	23	46	39	2	29	0	A	6.9	7.4	0.11	17	58	0	25	0	0	17	0	0	17	66	0	50	50
		MacRae Bk	18-Aug	10.5	12.3	0	217	14	4	0	A	6.9	4.1	0.17	0	25	0	58	0	17	67	8	0	25	0	83	0	16
		Adelaide Bk	18-Aug	14.1	17.3	0	4776	71	54	0	A	7.1	2.9	0.11	0	33	0	0	0	67	25	17	0	58	0	0	50	50
	Tusket	Coldstream Bk	29-Jul	22.5	23.6	83	1	1	0	0	P	4.6	8.2	0.18	0	42	0	33	0	25	17	8	0	17	58	8	42	50
	Roseway	Main Branch Roseway	29-Jul	21.6	24.5	56	0	0	0	0	P	4.4	9.3	0.23	0	33	0	58	0	8	92	17	0	17	0	0	50	50
		Turtle Cr	29-Jul	16.8	21.7	12	59	3	0	0	A	5.5	3.7	0.18	67	8	0	0	0	25	0	0	0	8	92	0	0	100
		Beaver Cr	29-Jul	20.2	27.7	47	0	0	0	0	P	4.8	7.8	0.23	0	0	0	0	0	100	8	8	13	33	43	0	25	75
	Annis	Norwood Fire Station	29-Jul	22.1	24	79	0	0	0	0	P	5.4	4.0	0.18	17	42	0	25	0	17	42	42	0	75	0	0	17	83
		Garden Mills	29-Jul	22.2	24.3	79	0	0	0	0	P	5.2	9.3	0.25	8	33	0	25	0	33	83	0	38	8	0	0	42	58
2004	Nine Mile	Carrigan Bk	19-Aug	13.4	15.4	0	45	8	0	0	P	6.8	5.5	0.16	33	25	8	8	0	25	33	58	25	58	0	0	58	42
		Captain MacPhee Bk	19-Aug	12.4	15.2	0	465	40	0	0	P	7.0	3.1	0.23	8	17	0	25	0	50	17	33	50	83	0	0	17	83
		Whittier Bk	19-Aug	10.9	14.8	0	1127	97	0	0	P	6.9	2.1	0.16	0	17	0	33	0	50	8	67	25	25	0	25	17	58
		Trib of Little Nine Mile	19-Aug	12.5	14.9	0	430	25	0	0	P	7.1	2.8	0.19	50	0	0	0	0	50	42	75	13	92	0	0	42	58
	River Phillip	Bulmer Bk	12-Aug	16.1	19.4	0	419	35	6	19	A	7.0	4.8	0.14	4	29	0	4	0	29	4	43	25	14	25	7	25	43
		Tillets Bk	12-Aug	21.6	27.0	58	24	10	0	9	P	6.8	8.7	0.16	0	75	0	8	8	8	17	8	25	25	33	33	8	58
	Wallace	Treen Bk	12-Aug	17.2	19.2	0	0	0	0	0	P	6.4	4.5	0.19	33	25	0	0	0	42	0	0	0	25	75	0	0	100
	Salmon	Farnham Bk	16-Sep	16.8	18.5	0	485	58	0	0	P	6.9	2.9	0.10	17	17	0	0	0	67	25	42	13	50	0	0	50	50
		Greenfield Bk	25-Aug	15.6	18.5	0	1022	101	0	0	P	6.5	2.0	0.12	0	100	0	0	0	0	25	33	38	8	9	58	0	25
		Clifford Bk	25-Aug	16	22.0	6	145	17	0	0	A	7.5	2.6	0.01	0	50	0	0	8	42	0	75	0	0	25	0	8	92
	Sackville	Payzants	23-Aug	19.8	22.4	35	0	0	0	0	P	7.6	4.8	0.29	33	25	0	8	0	33	0	42	0	25	33	0	92	8
		Straton Court	23-Aug	19.9	23.9	38	0	0	0	0	P	5.7	4.9	0.24	8	0	0	92	0	0	0	75	0	17	8	8	83	8

Appendix B. Water temperature, salmonid population densities, and habitat data collected from 100 electrofished stream sites in 2002 - 2005 in Nova Scotia.

				Water temp °C		Number	Brook trout		Atl	Brn t	Comp		Mean	Mean	Substrate Percentages					Cover Percentages						Water Char Percentages		
				mean	warm	of days		per	Sal	per	Species		width	depth														
Year	System	Site	Date	sum	daily	>20°C	g/100m²	100m²	100m²	100m²	P / A	pH	m	m	S	Co	B	R	Be	G	In	Ca	Un	O	NC	Ri	Ru	F
2005	St. Mary's	Indian Man Bk	11-Jul	16.4	20.7	2	25	3	9	0	P	7.1	3.4	0.16	0	33	0	58	0	8	42	42	12	8	33	0	33	58
		Sutherland Bk	11-Jul	16.7	19.0	0	388	19	7	0	P	7.9	2.6	0.15	33	25	0	0	0	67	17	50	38	58	8	0	25	75
		MacDonald Bk	11-Jul	17.3	20.5	2	98	4	3	0	P	6.9	6.0	0.2	33	67	0	25	0	0	8	50	25	25	25	0	8	92
		Glencross Bk	12-Jul	18	21.1	7	38	4	8	0	P	6.7	4.1	0.17	0	83	0	17	0	0	58	58	25	8	0	0	42	58
		Clark Bk	11-Jul	15.7	18.7	0	103	37	37	0	P	7.1	3.5	0.12	67	25	0	8	0	50	58	50	25	33	8	0	25	75
		Chisholm Bk	11-Jul	16.3	18.1	0	233	9	16	0	P	6.5	4.2	0.16	0	25	0	33	0	42	33	42	12	50	42	0	25	75
		Mitchell Bk	11-Jul	16.5	19	0	268	14	0	0	P	7.4	3.5	0.09	0	8	0	75	0	17	58	100	12	17	0	0	33	67
		Archibald Mill Bk	12-Jul	16.7	20.8	7	15	6	0	0	P	7.7	3.9	0.19	0	33	0	58	0	8	92	33	12	25	0	0	0	100
		MacDonald Mill Bk	11-Jul	16.9	19.2	0	64	11	1	0	A	6.7	3.3	0.12	0	33	0	50	0	17	41	45	13	46	0	0	50	50
		Long John Bk	12-Jul	17	20.3	1	10	7	15	0	P	7.7	5.0	0.13	0	33	0	67	0	0	75	17	25	0	17	0	67	33
		McLeod Lake Bk	12-Jul	20.4	23.5	43	215	17	3	0	P	7.2	3.0	0.09	0	42	0	8	0	50	75	25	0	83	17	0	8	92
	Tusket	Carleton Bridge	5-Jul	20.8	24.6	58	0	0	0	0	P	5.0	11.1	0.34	33	50	8	25	0	8	0	92	0	0	8	0	50	50
		Big Brazil Bk	4-Jul	21.6	24.7	74	0	0	0	0	P	7.1	4.3	0.37	100	0	0	0	0	0	0	50	0	50	8	0	0	100
	Annis	Big Brazil Lake	5-Jul	21.4	22.6	79	0	0	0	0	P	6.1	2.6	0.25	83	17	0	0	0	0	0	67	0	25	33	0	17	83
		Saunders Road	4-Jul	22.1	24.7	77	0	0	0	0	P	6.4	13.2	0.36	0	67	0	25	0	8	0	75	0	33	25	0	42	58
	Avon	Mill Bk	13-Jul	17.7	20.9	2	668	12	0	0	P	6.5	2.8	0.2	0	25	0	42	0	33	67	58	12	42	8	0	0	100
		Allen Bk	13-Jul	19.9	23.2	43	0	0	0	0	P	6.2	2.2	0.2	67	0	0	17	0	67	75	0	0	50	8	0	50	50
		LeBreau Cr	13-Jul	21.6	26.3	58	9	2	0	0	A	6.4	3.0	0.3	0	8	0	92	0	0	0	0	0	12	75	17	0	25	75
	Clyde	Lyles Hill Bk	6-Jul	20.4	25	49	0	0	0	0	P	4.2	4.6	0.24	0	50	33	17	0	0	0	0	50	0	42	33	0	50	50
		Bloody Cr	6-Jul	20.7	22.4	74	0	0	0	0	P	4.6	6.5	0.17	100	0	0	0	0	0	33	0	25	0	50	0	0	100
	Sackville	Little Sackville	27-Jul	19.5	25	35	35	1	14	0	P	5.5	7.5	0.08	0	8	0	50	0	17	50	58	38	25	8	0	0	100
		Feely Lake	27-Jul	22.4	25.8	70	0	0	0	0	P	6.0	3.0	0.15	25	17	0	0	0	58	58	42	25	50	8	0	0	100
	Cornwallis	Rochford Bk	27-Jul	13.8	16.8	0	626	41	0	148	P	6.5	3.1	0.19	25	0	0	25	0	50	58.33	25	12.5	66.7	0	0	50	50
Mean				17.3	20.9	20	449	25	6	3	63%	6.7	4.5	0.18	16	32	2	20	1	31	24	40	8	29	24	9	26	64

warm : warmest

Atl sal Atlantic salmon, Brn t : brown trout

Comp Species : Salmonid competitors : P = present A = Absent

Salmonid competitors: White sucker, Yellow perch, Eel, Smallmouth bass, Gaspereau, Brown bullhead

* = percentage of sites with competitors of brook trout

m = meters g= grams inter = intermediate

Substrate: S=silt, Co=cobble, B=boulder, R=rock, Be=Bedrock, G=gravel

Cover: In=instream, Ca=canopy, Un=undercut, O=overhang, NC=no cover

Water char : Water Characteristic: Ri=riffle, Ru=run, F=flat

Appendix C. Mean water temperatures and fish population densities from 100 electrofished stream sites in 2002-05 in Nova Scotia.

Year	Station	Site	Summer mean water temp°C	pH	Number of fish per 100m² Brook trout	Brown trout	Atlantic salmon	Salmonids	White sucker	Yellow perch	Eel	SMB	Brown bullhead	Gas	Chain Pickerl	Stickle back	Killi fish	Cyprinids	Total Competitors
2002	East River	Mill Stream Bk	19.8	7.5	6	0	14	20	0	0	0	0	0	0	0	0	0	2	0
		Archibald Bk	17	7.5	1	3	9	13	0	0	0	0	0	0	0	0	0	1	0
		Cameron BK	17.6	6.7	21	0	19	40	0	0	0	0	0	0	0	0	0	0	0
		West Branch	19.6	6.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Thompson Bk	15.7	6.4	51	0	0	51	0	0	0	0	0	0	0	0	0	0	0
		Little River	15.8	6.6	35	0	0	35	0	0	0	0	0	0	0	0	0	0	0
	Margaree /	Saddlers Bk	18.4	6.8	12	0	0	12	0	0	0	0	0	0	0	0	0	0	0
	Lake Ainslie	Dan MacDonald Bk	16.9	7.5	63	0	0	63	0	0	0	0	0	0	0	0	0	0	0
		MacMillan Bk	14.7	6.5	54	0	0	54	0	0	0	0	0	0	0	0	0	0	0
		Johnson Bk	12.3	6.5	90	0	0	90	0	0	0	0	0	0	0	0	0	0	0
		MacSweens Bk	13.5	6.4	30	0	0	30	0	0	0	0	0	0	0	0	0	0	0
	River Denys	Alder River	13.2	7.8	76	0	25	101	0	0	0	0	0	0	0	0	0	0	0
		Glen Bk	15.4	7.6	46	0	10	56	0	0	0	0	0	0	0	0	0	0	0
		McIntyre Bk	16.9	7.3	8	1	1	10	0	0	0	0	0	0	0	0	0	0	0
		MacLellans Bk	17.8	7.7	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0
		Big Brook	18	7.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Annapolis	McGee Bk	14	7.5	58	0	0	58	8	0	0	0	0	0	0	0	0	25	8
		Wiswall River	18.1	7.0	23	0	0	23	3	0	0	0	0	0	0	0	0	0	3
		Round Hill River	20.9	6.9	0	0	1	1	0	0	8	0	0	0	0	0	0	3	8
		Bloody Creek	20.5	7.0	2	0	2	4	1	0	0	0	0	0	0	0	0	2	1
		Paradise Bk	19.1	6.8	6	0	1	7	1	0	2	0	0	0	0	0	0	5	3
		Patterson Bk	15.8	7.7	332	0	0	332	0	0	2	0	0	0	0	2	0	0	2
	Habitant	Sleepy Hollow Bk	14.5	7.7	135	0	0	135	0	0	0	0	0	0	0	0	0	0	0
		Pereaux Bk	11.4	7.8	81	0	0	81	0	0	0	0	0	0	0	0	0	0	0
		Upper Habitant	13	7.4	136	0	0	136	0	0	2	0	0	0	0	0	0	29	2
	Cornwallis	Sharpes Bk	13.1	7.1	41	9	0	50	0	0	2	0	0	0	0	0	0	0	2
		Tupper Bk	17	7.1	63	0	0	63	0	0	0	0	0	0	0	0	0	0	0
		Brandywine BK	17.3	7.4	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0
		Spidle Bk	13.4	7.1	35	72	0	107	0	0	0	0	0	0	0	0	0	0	0
	Kennetcook	Birch Bk	16.1	7.0	5	0	0	5	6	0	0	0	0	0	0	0	0	12	6
		Rines Bk	20.1	7.2	0	0	0	0	15	0	35	0	0	0	0	0	0	30	50
		Hanna Bk	19.4	7.1	0	0	0	0	15	0	9	0	0	0	0	0	0	18	24
		Upper Kennetcook	16.6	7.0	19	0	0	19	1	0	0	0	0	0	0	0	0	8	1
	Musharnush	Blockhouse Mill Bk	19.1	7.0	0	0	1	1	7	0	3	0	0	0	0	0	0	24	10
		Musharnush River	20.7	6.7	0	0	2	2	1	0	3	0	0	0	0	0	0	0	4
		Naas Bk	19.5	6.8	14	0	0	14	3	0	8	0	0	0	0	1	0	17	11
		Musharnush R by lake	19.1	6.9	0	0	1	1	0	0	5	1	0	0	0	0	0	8	6
		Caribou Bk	18.2	6.9	0	0	1	1	2	0	0	0	0	0	0	0	1	5	2
		Big North Bk	22.6	5.7	0	0	0	0	1	0	15	0	0	0	0	0	0	3	16
	Petite Riviere	Warnback Mill Bk	17.3	5.7	15	0	4	19	1	0	0	0	0	0	0	0	0	0	1
		Petite Riviere	21	6.3	0	0	8	8	0	0	0	0	0	0	0	0	0	0	0
	La Have	Rhyno Bk	23.8	6.0	0	0	3	3	0	1	0	0	1	2	0	0	1	4	2
		Ash Bk	16.7	5.7	17	0	3	20	5	12	0	0	0	0	0	0	0	0	17
		Cooks Bk	17.8	6.5	8	0	36	44	3	0	3	0	0	0	0	0	0	11	6
		Varner Bk	13.1	6.2	23	0	4	27	17	0	0	0	0	0	0	3	0	4	17

Appendix C. Mean water temperatures and fish population densities from 100 electrofished stream sites in 2002-05 in Nova Scotia.

Year	Station	Site	Summer mean water temp°C	pH	Number of fish per 100m²													
					Brook trout	Brown trout	Atlantic salmon	Salmonids	White sucker	Yellow perch	Eel	SMB	Brown bullhead	Gas	Chain Pickerl	Stickle back	Killi fish	Cyprinids	Total Competitors
2003	Wallace	Drennan Bk	19.9	7.5	0	0	52	52	5	0	0	0	0	0	0	2	30	33	5
	St. Mary's	Nelson Bk	20.4	7.1	1	0	3	4	22	0	0	0	0	0	0	0	0	3	22
		Cross Bk	16.9	6.4	0	0	10	10	14	0	1	0	0	0	0	0	0	23	15
		Kelly Bk	16.7	5.9	24	0	0	24	0	0	0	0	0	0	0	0	0	0	0
		Barren Bk	18.4	5.7	5	0	30	35	9	0	3	0	0	0	0	0	0	8	12
	Middle	MacLeod Bk	13.5	7.5	8	0	22	30	0	0	0	0	0	0	0	0	0	0	0
		Morrison Bk	12.8	7.8	11	0	65	76	0	0	0	0	0	0	0	0	0	0	0
		MacKenzie Bk	13.5	7.6	30	0	27	57	0	0	0	0	0	0	0	0	0	0	0
		MacDonald Bk	10.1	7.1	148	0	4	152	0	0	0	0	0	0	0	0	0	0	0
	Baddeck	Harris Bk	14.6	7.3	38	0	7	45	0	0	0	0	0	0	0	0	0	0	0
		Mill Bk	13.4	7.3	20	0	13	33	0	0	0	0	0	0	0	0	0	0	0
		Morgan Bk	19.6	6.9	2	0	29	31	0	0	0	0	0	0	0	0	0	0	0
		MacRae Bk	10.5	6.9	14	0	4	18	0	0	0	0	0	0	0	0	0	0	0
		Adelaide Bk	14.1	7.1	71	0	54	125	0	0	0	0	0	0	0	0	0	0	0
	Tusket	Coldstream Bk	22.5	4.6	1	0	0	1	0	0	23	0	0	42	0	0	0	0	23
	Roseway	Main Branch Roseway	21.6	4.4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
		Turtle Cr	16.8	5.5	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0
		Beaver Cr	20.2	4.8	0	0	0	0	0	2	4	0	0	0	0	0	0	0	6
	Annis	Norwood Fire Station	22.1	5.4	0	0	0	0	0	0	38	0	0	0	0	0	0	0	38
		Garden Mills	22.2	5.2	0	0	0	0	0	0	98	0	0	0	0	0	0	0	98
2004	Nine Mile	Carrigan Bk	13.4	6.8	8	0	0	8	0	0	9	0	0	0	0	1	0	0	9
		Captain MacPhee Bk	12.4	7.0	97	0	0	97	0	0	9	0	0	0	0	0	0	0	9
		Whittier Bk	10.9	6.9	40	0	0	40	0	0	11	0	0	0	0	2	0	20	11
		Trib of Little Nine Mile	12.5	7.1	25	0	0	25	2	0	0	0	0	0	0	0	0	0	2
	River Phillip	Bulmer Bk	16.1	7.0	35	6	19	59	0	0	0	0	0	0	0	0	0	0	0
		Tillets Bk	21.6	6.8	10	0	9	19	3	0	0	0	0	0	0	1	0	10	3
	Wallace	Treen Bk	17.2	6.4	0	0	0	0	17	0	0	0	1	0	0	1	0	35	18
	Salmon	Farnham Bk	16.8	6.9	58	0	0	58	0	0	3	0	0	0	0	0	0	0	3
		Greenfield Bk	15.6	6.5	101	0	0	101	0	0	7	0	0	0	0	0	0	2	7
		Clifford Bk	16	7.5	17	0	0	17	0	0	0	0	0	0	0	0	0	0	0
	Sackville	Payzants	19.8	7.6	0	0	3	3	3	0	12	0	0	0	0	0	0	3	15
		Straton Court	19.9	5.7	0	0	11	11	1	0	6	0	0	0	0	0	0	1	7